Œconomia
History, Methodology, Philosophy

10-3 | 2020
Facts in Energy and Environmental Economics

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Electronic version
URL: http://journals.openedition.org/oeconomia/9722
DOI: 10.4000/oeconomia.9722
ISSN: 2269-8450

Publisher
Association Œconomia

Printed version
Date of publication: 1 September 2020
Number of pages: 555-578
ISSN: 2113-5207

Electronic reference
Kirsten Sophie Hasberg, « Constructing Viking Link: How the Infopower of Cost-benefit Analysis as a Calculative Device Reinforces the Energopower of Transmission Infrastructure », *Œconomia* [Online], 10-3 | 2020, Online since 01 September 2020, connection on 27 December 2020. URL : http://journals.openedition.org/oeconomia/9722 ; DOI : https://doi.org/10.4000/oeconomia.9722

Constructing Viking Link: How the Infopower of Cost-benefit Analysis as a Calculative Device Reinforces the Energopower of Transmission Infrastructure

Kirsten Sophie Hasberg*

This paper sheds light on the performativity of economics in the decision-making process behind Viking Link, a Danish-British interconnector under construction. It shows how energopower, that is, the political power inherent to energy infrastructures, is reinforced through the workings of cost-benefit analysis as prescribed by the Danish Ministry of Finance. In doing so, the paper offers a novel approach to the performativity of calculative devices, highlighting the role of infopower, a Foucauldian neologism denoting the power inherent to information structures. Calculative devices are understood as information infrastructures that exert power through the work of data formatting. The cost-benefit analysis, as such a calculative device, limits the potential valuations of Viking Link and hence restricts decision-making. This has impactful consequences, as the infopower of mainstream economic thinking makes it possible to disregard relevant aspects of Viking Link, like its (lacking) contribution to decarbonization and alternatives to interconnectors as ways of integrating fluctuating renewable energy.

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Above all, I would like to thank the many colleagues of the Sustainable Energy Planning group at Aalborg University, Denmark, involved in raising questions about Viking Link, particularly professor Frede Hvelplund, whose freedom from thought constraints continues to inspire me. Thank you to the "Valuation" special interest group and to the participants of the "Social Studies of Energy System Transitions Through Shifting Valuations and Agencies" conference in October 2019, both hosted by the Department of Planning at Aalborg University Copenhagen, for valuable comments on previous versions of this paper. I am grateful to professor Jörg Niewöhner for bringing my attention to Ludwik Fleck's conception of facts during my research stay at the Integrative Research Institute on Transformations of Human-Environment Systems at the Humboldt University Berlin in 2018. Finally, I would like to thank three anonymous reviewers and the Special Issue editors for their helpful and thorough suggestions. This research was financed by the Danish ForskEL and EUDP Programs through the Energy Collective Project (Grant no. 2016-1- 12530).

Keywords: cost-benefit analysis, calculative device, infrastructure, Viking Link, electric power transmission, performativity of economics, energy transition

Construire le *Viking Link* : comment l'*Infopower* de l'analyse coût-bénéfice comme dispositif de calcul renforce l'energopower de l'infrastructure de transmission

Cet article met en lumière la performativité de l'économie dans le processus décisionnel derrière *Viking Link*, un interconnecteur britannico-danois en construction. Il montre comment l'*energopower*, c'est-à-dire le pouvoir politique inhérent aux infrastructures énergétiques, est renforcé par le fonctionnement de l'analyse coût-bénéfice prescrite par le ministère danois des finances. Ce faisant, l'article propose une nouvelle approche de la performativité des dispositifs de calcul, mettant en évidence le rôle de l'*infopower*, un néologisme foucaldien désignant le pouvoir inhérent aux structures d'information. Les dispositifs de calcul sont entendus comme des infrastructures d'information qui exercent un pouvoir grâce au travail de formatage des données. L'analyse coût-bénéfice, en tant que tel un dispositif de calcul, limite les évaluations potentielles du *Viking Link* et restreint donc la prise de décision. Cela a des conséquences importantes, car l'*infopower* de la pensée économique traditionnelle permet de ne pas tenir compte des aspects pertinents du *Viking Link*, tels que sa contribution (manquante) à la décarbonisation et les alternatives aux interconnecteurs comme moyens d'intégrer des énergies renouvelables fluctuantes.

Mots-clés : analyse coût-bénéfice, instrument de calcul, infrastructure, Vikink Link, transmission d'énergie électrique, performativité de l'économie, transition énergétique

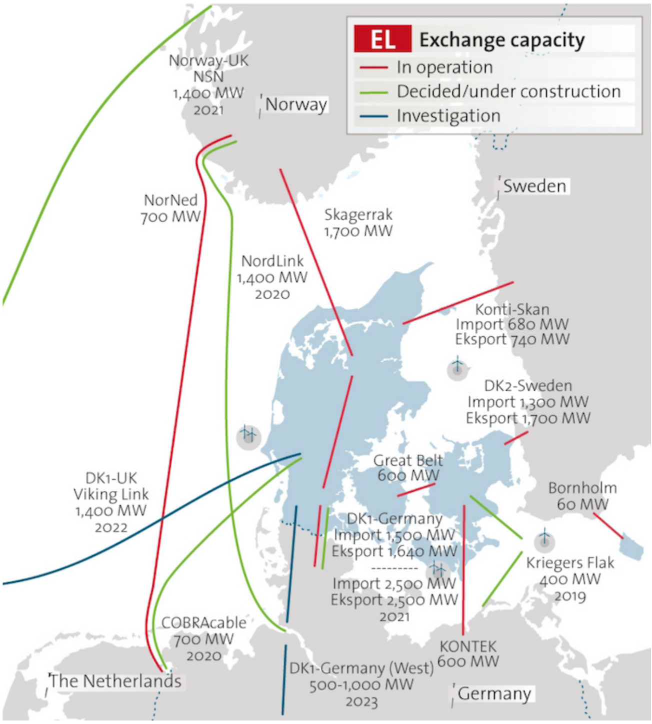
JEL: L94, Z13, D61, Q48

Following the call of the special issue editors to study the "the way environmental and energy economics conceive, construct and refer to 'facts'" (Erreygers, Gaspard and Missemer, 2019, §2), this article conceptualizes cost-benefit analysis (CBA) as a calculative device producing facts in political decision-making processes, and presents an energy sector case study on the workings and effects of such facts. Based on a review of available documentation of the Danish CBA regarding the Danish-British interconnector Viking Link, I offer a novel conceptual approach to understanding the powerful performative effects that this tool from the energy and environmental economic toolbox can have. The paper is structured as follows: After introducing the case of the interconnector Viking Link and the research question it gives rise to, section 1 presents the analytical concepts invoked, namely a conception of facts (1.1) embedded in the notion of the performativity of economics (1.2). Section 2 offers an analysis of the Danish CBA with specific focus on the welfare-economic foundations and concepts (2.1 and

2.2) and the treatment of selected factors like CO2 emissions (2.3), the alternative scenarios (2.4) and risk (2.5). Sections 3 concludes.

Viking Link, a 760-kilometer-long Danish-British interconnector under construction is set out to connect the two countries with an electric transmission capacity of 1.4 gigawatt (GW) by 2023 (NationalGrid and Energinet, 2020) at an estimated cost of 1.5 billion EUR for the Danish share alone (EFKM, 2018). Like other transmission and distribution costs of electricity, this infrastructure megaproject (Flyvbjerg, 2017) is billed to residential and commercial electricity consumers via electricity grid tariffs, in line with the current Danish revenue cap regulation of electricity infrastructure. Furthermore, Viking Link receives support from the EU interconnector financing mechanism "Projects of Common Interest" (European Commission, 2019). The map in Figure 1 shows Viking Link seen from a Danish perspective. For Energinet, the Danish Transmission System Operator (TSO) responsible for the Danish share of Viking Link, the investment follows recent ones in the Danish-Dutch Cobra cable and the Danish-German "Krieger's Flak Combined Grid Solution," which both went into operation in 2019.

Figure 1. Existing and Planned Interconnectors to/from Denmark



Source: Energinet and Energistyrelsen (2018), Baltic InteGrid (2019) and ENTSO-E (2019)

As the Danish TSO Energinet is a publicly owned entity, Viking Link was subject to Danish ministerial approval which it received in 2017 (EFKM, 2017b) and approval by the British regulator, the Office of Gas and Electricity Markets (Ofgem) in 2015 and 2017. Approvals were given based on cost-benefit analyses, described as so-called business cases by the involved parties. The business case, describing the economic interest in Viking Link (and in other interconnectors between mainland Europe and the UK) hinges on a relatively large price gap between the UK and continental Europe, giving rise to arbitrage rents, that is, gains from trade between the higher priced British and the lower priced continental European systems. Ceteris paribus, Viking Link increases average prices in Denmark and decreases them in Britain. As such, the cost-benefit-analysis of Viking Link is strongly tied to welfare-economic assumptions as applied in energy and environmental economics.

The Danish decision to construct Viking Link has been subject to critique (Mathiesen et al., 2018; Hasberg et al., 2018) and has acted as an "anchor for societal conflict" (Hasberg, 2021) regarding the future development of the energy system. This situation was augmented by the fact that numbers were redacted in the Danish documents (Energinet.dk and Tennet, 2011; Energinet.dk, 2012; Brendstrup, 2013; Energinet.dk, 2013a; KEBM, 2013) and made public only after approval (Energinet, 2017c; 2017b; Energistyrelsen, 2017).[1] In contrast to Lind's (1982) advice to use CBA as "a guide for decision-making," not "as a substitute for judgment", CBA seemingly replaced political and public debate in the Danish decision-making process. Although the conflict itself is outside the scope of this article, it makes it even more important to take a closer look at how the results of the CBA came about: How did cost-benefit analysis act as a fact-making calculative device, leading to the construction of Viking Link?

1. Analytical Concepts

1.1 A Fleckian Conception of Facts

This article is based on a Fleckian understanding of the term *fact*, as formulated in *Genesis and Development of a Scientific Fact* (Fleck, 1979 [1935]). To Fleck, there are three factors involved in the making of a fact: "the individual, the [thought] collective, and objective reality (that which is to be known)" (1979, 40). A thought collective is a community of practice (Lave and Wengers, 1991) that exchanges ideas and develops a shared thought style of which the individual is "never, or hardly

[1] This is in contrast to the situation in the UK where cost-benefit analysis was public and consultations were held (Pöyry, 2014; Ofgem, 2015; RenewableUK, 2015; SSE, 2015).

ever, conscious" (Fleck, 1979, 42). Thought styles are characterized by delimiting what is considered to be relevant and what is considered to be irrelevant.

Following Fleck, the facts that enter a decision-making process are thus a result of: (1) That which is to be known: In this case, modelling of future energy flows with and without the interconnector; (2) The knower: In this case, the analysts producing the cost benefit analysis); (3) The thought collective, restricting what can be known: In this case study, the thought collective is represented through the calculative device of the cost-benefit analysis. A cost-benefit analysis can thus be understood as an institutionalization of the welfare-economic thought collective. Although Ludwik Fleck with his concept of thought collectives emphasizes the role of what Karin Knorr-Cetina's (1999) calls "epistemic culture" in the construction of facts, Fleck was certainly not a pure social constructionist as Barbara Herrnstein Smith (2006) emphasizes. Therefore, Fleck's conceptualization of facts does not conflict with, but rather is compatible to, newer socio-material concepts that Actor-Network-Theory and Science and Technology Studies have given rise to, such as "calculative devices" (Muniesa and Callon, 2005) and "infopower" Koopman (2019), to which I turn in the following section 1.2.

1.2 From the Performativity of Economics to the Infopower of Calculative Devices

The performativity thesis[2] of economics in general and of markets more specifically emerged in Science and Technology Studies and was developed in the 1990s (Çalışkan and Callon, 2010; Fligstein and Calder, 2015). It describes that economic theory does not just represent, but shapes—that is, *performs*—reality. Thus, economists and their "calculative devices" (Callon and Muniesa, 2005) "make markets" (MacKenzie, Muniesa and Siu, 2007).

Performativity thus entails a form of power to shape the world. To emphasize this power of calculative devices, I introduce the concept of *infopower* coined by Colin Koopman (2019) in *How We Became Our Data*. It signifies the power inherent to structures that format information, and calculative devices such as cost-benefit analysis can be understood as such a structure. Calculative devices format information and feed it into public debates, changing their outcomes, and thereby performatively exerting infopower. As a neologism based on the Foucauldian term biopower (Foucault, 2008), infopower emphasizes the agency of

[2] For discussion of economic performativity in this journal, see Brisset (2011, 2017) Maas, Medema and Guidi (2019).

both human and non-human actors (Lemke, 2015).[3] It provides a way of understanding how calculative devices themselves exert power by making economists follow calculative rules, even before they have made any conscious choices as human actors.

As calculative devices, economic models and methodologies like cost-benefit analysis, here analyzed in its specific version as defined by the Danish Ministry of Finance, function as informational infrastructures to which infopower is inherent. This becomes especially clear when considering the de facto status of law of the cost-benefit guidelines of the Danish Ministry of Finance. The

> officially recommended method for socioeconomic calculation [in Denmark] consequently functions as a de facto regulation. It is not a direct regulation in terms of a law passed by the parliament, but guidelines issued by the Ministry of Finance set the standard for 'correct socioeconomic calculation' … The guidelines are not formally enforced by the state though they may be subject to de facto enforcement. (Djørup, 2020, 6)

The Viking Link interconnector case study in this paper offers an opportunity to take a close-up look at how the facts emerging from cost-benefit analysis exert infopower, and how this interacts with energopower (Boyer, 2019). As infopower, energopower is derived from the Foucaldian term biopower and describes how infrastructures, political structures and capital structures of incumbent fossil energy players create path dependencies and lock-ins that restrict the energy futures imaginable (Hasberg, 2019a).

2. Analysis of the Danish Viking Link CBA

Fundamentally, cost-benefit-analysis aims at assessing the investment costs of a project today compared to future benefits in terms of net present value.[4] The CBA methodology is derived from microeconomic welfare theory (see section 2.1 and 2.2) while the selection of components to be included makes up the concrete project appraisal (see section 2.3, 2.4 and 2.5).

Following a Danish perspective, there exist a number of Danish guidelines on CBA, published by different ministries. The Ministry of Finance is regarded as the authoritative reference guideline (Finansministeriet, 1999) which has been updated since the original Energinet

[3] Here, I am not exploring Foucault's positioning in the history of economic thought, see instead Vallois (2015) and Newheiser (2016) for two different interpretations.

[4] Energinet applies the 4% discount rate suggested by the Danish Ministry of Finance (Finansministeriet, 2018) to Viking Link. "The discount rate recommended by the Ministry of Finance has recently been elevated to a formally mandatory status" (Djørup, 2020, 6). The rate of discounting is not made subject of further analysis in this paper, as it is an aspect that is frequently subject to analysis and critique, see for example Hasberg (2008).

calculations were made (Finansministeriet, 2017). In addition, the Danish Energy Authority publishes specific guidelines for energy projects (Energistyrelsen, 2018d). Energinet has also published a guide to their appraisals in connection with the Viking Link debate (Energinet, 2017a).[5] In spite of the goal of CBA to make projects comparable, no general consensus exists on how to practice CBA. As De Nooij (2011, 3100) states, "a project's approval may depend on which government's department has to approve."

The object of analysis is summarized in Figure 2 below, showing a summary of the CBA done by Energinet and by the Danish Energy Authority, based on four different electricity market models: BID or "Better Investment Decisions", is the model used by Energinet, whereas Ramses and Balmorel are the models used by the Danish Energy Authority, while the last column BF2017 uses updated assumptions.

Figure 2. Cost Benefit Analysis of Viking Link, Net Present Value, 2017

(NPV mia. kr. 2017)	BID	Ramses	Balmorel	BF2017
Flaskehalsindtægt	10,3	7,5	9,1	9,2
Forbrugerunderskud	-7,0	-7,3	-8,0	-3,5
Producentoverskud	8,8	9,6	9,9	3,8
Staten	0,7	0,4	0,8	0,5
Investering	-7,7	-7,7	-7,7	-7,7
Udetid	-1,0	0,0	-1,0	0,0
Øvrige poster	0,6	0,6	0,6	0,6
Nettogevinst	**4,7**	**3,1**	**3,6**	**2,9**

Translation of Danish terms, from top to bottom: arbitrage rents, consumer surplus, producer surplus, investment, taxation surplus, outage time, miscellaneous, net gain. Source: Energistyrelsen (2017).

2.1 Welfare-Economic Foundations and Arbitrage

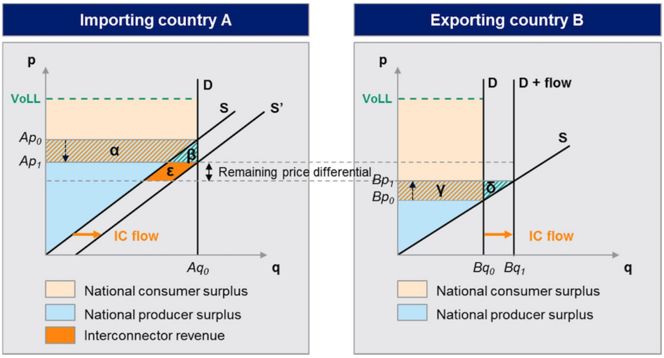
The first and second fundamental welfare theorems of microeconomic theory are at the root of cost-benefit analysis. They assert that under perfect competition, full information, no barriers to entry, no transaction costs and certain assumptions about the preferences of individuals, every market equilibrium is Pareto efficient (Pareto, 2014 [1906]), that is, there is "no alternative state that would make some people better off without making anyone worse off" (EB, 2018). When a Pareto improvement makes some actors better off at the expense of others, then those who are made better off could potentially compensate the

[5] A separate guide on environmental projects was previously published by the Ministry of the Environment (Møller et al., 2000), but is no longer updated.

losers, although this compensation does not have to take place. This is known as the Kaldor-Hicks compensation principle.

To understand this theory as applied to an interconnector, an additional concept is needed: that of third degree price discrimination (Pigou, 1932). It describes a situation where two separate groups of consumers, for example at different geographic locations, are charged a different price for the same good. Third degree price discrimination leads to Pareto inefficiency, because of the welfare loss caused by lost consumption possibilities. It can be alleviated through arbitrage, that is, by buying in the higher and selling in the lower priced market through an interconnector, as shown in Figure 3. The low-priced country B on the right-hand side of Figure 3 could represent Denmark in the Viking Link case, as Danish wholesale electricity prices are low due to high wind shares: On electricity exchanges like the Nordic NordPool market, windy hours result in a large supply of electricity at short-term marginal costs close to zero, exerting a downward push on the market clearing price. In Figure 3, Britain is the importing country A on the left panel. Arbitrage will make prices converge until they abide to the 'law of one price' which, according to welfare economic theory, leads to Pareto optimality. In energy sector terms, this amounts to a 'copper plate' assumption, that is, full interconnection meaning that no bottlenecks inhibit trade. As I will show in section 2.4, this limits the extent to which alternatives to cross-country price zone integration, namely cross-sectoral integration, is taken into consideration in the analysis of whether to go forward with the interconnector project Viking Link or not. The welfare-economic assumption of Pareto optimality exerts infopower by implicitly reaching for optimality across borders, not across sectors.

Figure 3. Fundamental Valuation of Interconnectors in Welfare Economics



Source: Pöyry (2014). Abbreviations used in the figure: D and S = Demand for and supply of electricity. IC = Interconnector. Ap = Price in country A; Bp = price in country B. β *and* δ = welfare gain. VoLL = Value of Lost Load.

The scholarly literature on energy infrastructure valuation in the field of energy economics confirms the welfare-economic thinking, assuming that benefits of interconnection arise from gains of trade (see for example Becker et al., 2014; Beato and Vasilakos, 2018). As Dutton and Lockwood (2017) write: "There is now a well-established theoretical literature, mainly economic, that has suggested reasons why greater interconnection has proved difficult to achieve in practice, despite the clear benefits to aggregate welfare, security of supply and competitiveness." Kemfert et al. (2015) and Schmidt and Lilliestam (2015) pose exceptions to this literature. Basing their CBA on different assumptions Kemfert et al. (2015) conclude that welfare losses are associated with *excessive* transmission capacity investment, not with a lack of transmission lines. This resonates with Rumpf and Bjørnebye (2019) who show that existing interconnectors in Europe are underutilized. In their dissection of CBA procedures of interconnector valuation, Schmidt and Lilliestam (2015) find that CBA "*obscures* rather than highlights different perspectives and values of stakeholders and biases transmission system planning towards a particular set of values" (Schmidt and Lilliestam, 2015, 120, my italics).

CBA thus instills a set of calculative rules that fasten the welfare-economic assumption of electricity arbitrage resulting in a Pareto improvement.

2.2 Consumer and Producer Surplus

In Figure 3, the welfare gains of trade are the beta and delta areas (green triangles), which are the sum of the (negative) change in consumer surplus, that is, the difference between willingness to pay and actual payment, and the (positive) change in producer surplus. As noted above, it is not necessary that the winners compensate the losers. In short, microeconomic welfare theory is the reason why an interconnected European electricity market is perceived as efficient.

As a consequence of the Kaldor-Hicks compensation principle, grid investments that do not pay off on purely commercial terms can be viable from a so-called welfare-economic point of view, even when this is at the loss of consumers. For Denmark as the exporting country B, interconnection will result in consumer welfare loss and producer welfare gain. Distributional effects therefore do not play any role in Danish CBA and are not specifically addressed in the Danish CBA guidelines (Finansministeriet, 2017). The use of CBA thus leads to a depolitization of distributional questions. To speak with the words of Ludwik Fleck (1979 [1935]), the welfare-economic thought collective speaks through the facts that the CBA produces, exerting infopower over what is considered relevant, that is, what is to be known and what to be ignored in the decision-making process. For Danish interconnectors, trade is assumed to result in an overall "welfare gain" composed of a "consumer loss" outweighed by a "producer surplus" because of today's relatively large price differential between Denmark and Britain. The Kaldor Hicks compensation criterion ensures that distributional effects can be disregarded.

2.3 CO2-Emmissions

Upon approval, the Danish Minister of Energy, Climate and Utilities announced that Viking Link will "turn green power into the new bacon" (Lilleholt, 2017), referring to the historical success of Denmark in selling bacon to Britain during the industrial revolution, although the modelling of Energinet shows that the profitability of the project hinges, among other things, on exporting German coal power to Britain via Denmark in the period from 2023-2030 (EFKM, 2017a, Question K), because British gas is replaced by German coal power, transited via Viking Link (Mathiesen et al., 2018; Hasberg et al., 2018). Importing fossil energy from continental Europe increases emissions from continental fossil generation units, and also their profitability. When fossil German power is imported via Viking Link, the British Carbon Price Floor[6] is by-passed, hence, eroding the British policy measure. Nevertheless, the CO2 effects in neighboring countries due to changed generation patterns are not part of the Energinet cost-benefit analysis.

That German coal power benefits from interconnectors between mainland Europe to the UK is a result found for Norwegian interconnectors as well (Hope, 2011; Thue, 2013; 2014). Nevertheless, echoing the promotion of Viking Link as an enabler of green electricity exports as expressed by the minister, Norway is described as acting as a "green battery of Europe" (Gullberg, 2013; Gullberg, Ohlhorst and Schreurs, 2014; Hethey et al., 2015).

The overall contribution of this interconnector project to a transformation of the European energy system away from fossil energy remains questionable. Nevertheless, the cost-benefit analysis (CBA) on which decision-making is based returned a positive result, resulting in the approval of the project. As such, it acts as a calculative device producing facts in a Fleckian sense, serving as accepted, unquestioned and mobile statements in the decision-making process, rendering questions regarding European CO2-emissions irrelevant. As the Minister states, CO2 effects are not included because the emissions take place inside the European Emissions Trading Scheme ETS. To discard emissions because they are taking place inside a quota market is common practice and recommended by the Danish CBA guidelines (Finansministeriet,

[6] The Carbon Price Floor (CPF) is the result of the British "Carbon Price Support" (CPS), a CO2 price top-up mechanism with the goal of decarbonizing the UK quickly and to make renewables more competitive. Hence, interconnectors are a way of importing fossil electricity into the UK that is not subject to the CPF carbon tax, circumventing the national carbon price floor (Guo, Newbery and Gissey, 2019).

2017; Energistyrelsen, 2018d). This renders the valuation of the link independent of its CO2 effects. Thus, the combination of two calculative devices, the cost-benefit analysis and the quota market, enables the disappearance of CO2 damage cost in cost-benefit analysis, an effect that Çalışkan and Callon (2009) and Madra and Adaman (2014) call "depolitization through economization."

2.4 Considering Alternatives to Interconnection

CBA compares a Business-As-Usual (BAU) scenario with the project scenario. However, when there is significant uncertainty about the BAU—which is the case in transformation processes—the comparison of only two states becomes a major way in which CBA facilitates ignorance.

A critical omission in the Energinet cost-benefit analysis is that increased sectoral integration between electricity, heating and transport in Denmark has not been taken into account. Infrastructural concerns can also be solved through market reorganization as an alternative to interconnection (Pallesen and Jacobsen, 2018), but "the national [Danish] guidelines for socioeconomic calculation … act as a potential barrier" (Djørup, 2020, 6) for alternative valuations.

Models of district heating in Norway show that sectoral integration affects the profitability and the flows on interconnectors (Askeland, Bozhkova and Sorknæs, 2019; Askeland, Rygg and Sperling, 2020). Energinet assumes that only 15% of the district heating demand in 2035 is covered by large heat pumps and electric boilers (Energinet.dk, 2014; 2016), cited in (Hvelplund and Djørup, 2020, 75). This is low compared to the Smart Energy Scenarios developed by Energinet itself (Energinet, 2018; 2019). Also, it does not consider the direct production of electrofuels for transportation using offshore wind (Ridjan, Mathiesen and Connolly, 2016).

Although Energinet *does* undertake scenario analyses inhouse of sectoral integration, most recently in a report on Power-to-X (Energinet, 2019) and in the System perspective 2035 scenario (Energinet, 2018), it is left out of the decision-making process. This type of scenario has not been considered in the analysis of Viking Link as it does not fit in the cost-benefit analysis approach comparing projects to a BAU scenario. The cost-benefit analysis methodology induces ignorance towards alternatives that are paradigmatically different to the proposed project.

Choosing the factors to be included and excluded in CBA requires the analyst to "think broadly" (Costanza, 2006), but the infopower of CBA itself acts in the opposite direction: It narrows the considerations that are considered to be relevant. The result is that sectoral integration as a flexibility measure, although constituting an alternative to international interconnection, is left out of the decision-making process on Viking Link. The calculative device restricts choices by defining alternative scenarios as outside the scope of CBA, which is problematic in a situation of system transformation.

2.5 Risk

Risk is typically included in CBA via sensitivity analysis. One of the fundamental risk elements of megaprojects is uncertainty regarding up-front costs and future benefits of the investment, and megaprojects are, generally speaking, prone to ex ante risk underestimation.[7] Under the current revenue cap regulation and TSO regulation, Danish consumers act as risk-bearers, incentivizing risk-taking behavior of Energinet. (The role of regulation in relation to risk is outside the scope of this paper; see instead Hasberg (2020, Chapter 8; and 2019b)).

The Energinet CBA includes sensitivity analysis through Monte Carlo simulation of a range of risk factors, concluding that there is an 88% probability that Viking Link will return a positive socio-economic value; that is, a risk of 12% that the interconnector will result in a socio-economic loss (Energinet, 2017d). However, since the sensitivity analyses are not mentioned in the summary presented by the Danish Energy Authority (Energistyrelsen, 2017), risk is downplayed in the presentation of results.

In the following, I take a closer look at how two specific risk factors: (1) Cannibalization effects arising from other interconnectors (2.5.1), and (2) wind power correlation, that is, simultaneous occurrence of wind events in the two price zones that the interconnector connects (2.5.2).

2.5.1 Cannibalization Effects

Cannibalization refers to how a "new interconnector may lead to an additional price convergence between the two regions, which would in turn reduce the congestion revenues that any pre-existing interconnectors across the two same zones would earn" (Australian Energy Regulator, 2018). Cannibalization effects on interconnectors without Danish involvement are excluded from the cost-benefit analysis but are listed in a separate table that is redacted (Energinet, 2017d, 14).

Energinet does include cannibalization effects on existing Danish interconnectors, but lump them together with arbitrage gains, making it impossible to identify the extent of cannibalization (Energinet, 2017c, 5). The sensitivity analyses include several scenarios for additional interconnection capacity, but the results contradict each other in the two available public versions of the business case. Energinet (2017c, 18) states that if an additional interconnector is established between Britain and Norway, the value of Viking Link is reduced by 336 million DKK;

[7] For an exploration of this argument, see Wachs, 1989; Flyvbjerg, Holm and Buhl, 2002; van Wee and Tavasszy, 2008; Sovacool and Cooper, 2013.

furthermore, a 1.4 GW interconnector between Britain and Germany will reduce the value of Viking Link by 443 million DKK. Contrast this to Energinet (2017a, 33), stating that a 2 GW interconnector between Britain and Germany will reduce the value of Viking Link by 809 million DKK.[8] It is not clear why the two estimates differ.

The lack of specification of the cannibalization effects is in contrast to the British analysis (Pöyry, 2014) that has a detailed methodology for assessing different cables and their cannibalization effects, modelling the "value as the first additional interconnector" and the "value as the marginal interconnector." Also the Norwegian analysis of the merchant interconnector between Norway and Scotland explicitly includes cannibalization effects (NorthConnect, 2017). With nine new interconnectors planned between the UK and the European continent, cannibalization effects seem underestimated in the analysis, implicitly accepting cannibalization effects on already existing, own lines as a "necessary evil." Accepting such a loss is typically the case when private companies attempt to win market shares as part of a growth strategy (Investopedia, 2019). This strategy hence points to Energinet not as a natural monopolist, but as a multinational competitor in the European market for interconnectors, a point that I elaborate on in Hasberg (2020a, Chapter 8).

2.5.2 Wind and other Renewables in the UK

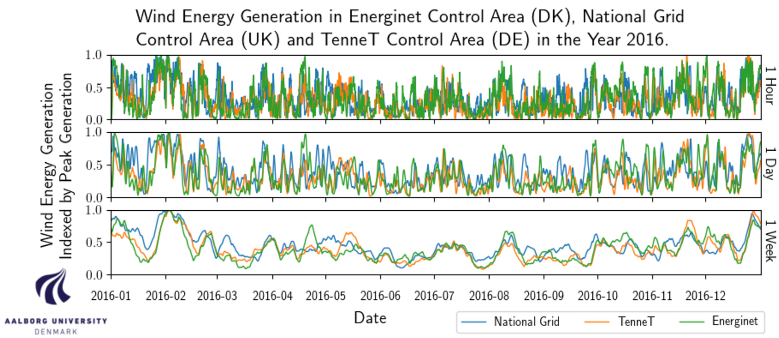
As already illustrated in section 2.4 on considering alternatives, system transformation is difficult to imagine within the formatting instilled by CBA. This section takes a closer look at system transformation as a risk to the profitability of the link due to the simultaneity of the incidence of wind in Denmark and the UK.

Renewable energy developments in Britain affect the valuation of Viking Link in two ways: through the amount of fluctuating renewable energy, and through its timing, that is, its degree of simultaneity with Danish fluctuating renewables (mostly wind power). As with the interconnector estimates in section 2.5.1 above, there are inconsistencies in the sensitivity analysis of the impact of large shares of wind in Britain in Energinet (2017a, 32), stating that significantly higher amounts of wind and solar power as described in the 2030 National Grid "Gone Green" scenario reduce the value of Viking Link by 2.84 billion DKK. Compare this to Energinet (2017c, 24), stating that the value of Viking Link *increases* by 544 million DKK if renewables are expanded according to the National Grid 2030 "Gone Green" scenario. It seems that the increasing shares of fluctuating renewables have been inconsistently considered in the Energinet analysis. This might be caused by the application of varying estimates of correlation: Energinet (2017b) states

[8] The interconnectors in question are probably NeuConnect and NorthConnect.

that correlation between Danish and UK wind is 0.42, but it is unclear which temporal resolution this correlation refers to.

Figure 4. Wind Energy Production in the Energinet, National Grid and TenneT Control Areas in the Year 2016 in Different Resolutions (Right Scale)



Source: Mathiesen et al. (2018).

However, the datasets for modelling the Danish and UK wind power profiles and their correlation are not public, hence it is difficult to assess these claims and the cause of the different results of the sensitivity analysis in Energinet (2017a) and Energinet (2017c). Figure 4 shows the correlation for historical wind data in different resolutions. It shows how sensitive the correlation is to the time resolution. If the wind blows simultaneously in the UK and Denmark, and the shares of wind increase in the UK, this reduces the economic viability of Viking Link because exports to a price area with similar weather patterns cannot be used to solve the problem of integrating large amounts of wind power in energy systems.

In sum, both the risk regarding cannibalization (2.5.1) and the risk regarding wind simultaneity (2.5.2) pose a risk to the economic viability of Viking Link that the CBA does not sufficiently confront just as scenarios of systems transformation towards more sectoral integration are left unconsidered (2.4). These findings echo those of Reinertsen and Asdal (2019) who state that numbers like the ones resulting from cost-benefit analysis can lead to the acceptance of "uncertainty and encourages risk-taking over precaution and constraint" (2019, 552), "closing off possibilities and uncertainties" (567).

3. Results: Infopower Reinforces Energopower

It becomes clear that many choices in cost-benefit analysis are restricted by methodological constraints derived from both microeconomic theory as well as CBA conduct as institutionalized in practice guidelines. The CBA methodology, even before active choices are made, strongly formats the way the world can be seen, for example, by referring to a business as usual scenario and thus exerting infopower and limiting the potential outcomes. Superimposing CBA assumptions of not valuing CO2 effects and ignoring alternatives because of BAU assumptions are two examples of how the results of a CBA might be difficult to reconcile with the reality of climate crisis.

CBA renders the asking of relevant questions, for example regarding CO2 emissions or systems transformation irrelevant as these elements cannot be considered within the CBA framework. Explicit political goals like reaching renewable energy targets do not form the basis of decision-making, which is rather governed by the fundamental assumptions of the welfare economic thought collective as represented by CBA procedures and its focus on arbitrage gains and changes in consumer and prosumer surplus.

This obscurity is a form of depoliticization (Bues and Gailing, 2016) as it removes relevant issues from the policy arena by decoupling relevant issues from calculative regimes (Reinertsen and Asdal, 2019, 553). The process of how specific arrangements of calculative devices of thought collectives constitute and reinforce forms of energopower echoes Gabrielle Hecht's notion of "technopolitics," which is the "strategic practice of designing or using technology to constitute, embody, or enact political goals" (Hecht, 2009, 15).

As Timothy Mitchell (2007, 248) emphasizes, instead of just ascertaining that the calculative devices of economics are performative, it is "useful to consider what kind of world the (mis)representation helps to organize." Thus, the "narrowness of neoclassical economics … serves a purpose" (Mitchell, 2007, 244). In other words, the performative effects must fall on fruitful political ground, as Marion Fourcade asserts (2011b, 15) in order to unfold. Ray Galvin (2020, 6) comes to a similar conclusion, arguing that economics is performative when it serves energopower, as Boyer (2019) terms the incumbent structures of the energy sector.

In the case of Viking Link, the calculative device of CBA reinforces the "constitutive power of energy infrastructures" (Bridge, Özkaynak and Turhan, 2018), the infopower of the cost-benefit-analysis *fastens* the path once taken, that is, holds the energy system in place by disregarding alternative ways of integrating renewable energy. With the construction of Viking Link, renewable energy is fastened in the same—both figurative and literal—power structures as fossil energy. Contrary to intuition, the energy transition does not act to loosen energopower, but fastens it, path-dependently reproducing the problematics of the fossil era. The infopower enacted by cost-benefit analysis makes it possible to disregard a number of otherwise relevant aspects in the analysis of Viking Link.

Djørup (2020, 5) confirms this link between infopower of calculative devices and energopower in relation to the treatment sectoral integration via district heating as an alternative to interconnection as discussed in section 2.4.: the Danish heat supply act requires "socioeconomic viability" of district heating projects and this viability must be demonstrated using current Danish CBA guidelines: "In practice … fossil fuel companies … can choose to bring a case to EBA [The Danish Energy Board of Appeal, Energiklagenævnet] if they see alternative methodological assumptions threatening their market shares." (Djørup, 2020, 6).

Due to correlation and seasonality (the simultaneous occurrence of renewable electricity production patterns across borders discussed in 2.5.2), new interconnectors like Viking Link alone cannot solve the problem of continuous supply of electricity in 100% renewable systems (Thellufsen and Lund, 2017; Brown et al., 2018), but the CBA analysis does not help decision-makers by highlighting this problem, but rather obscures it. The real-existing construction of Viking Link will enable trade smoothing out price peaks and troughs, eroding the economic viability of domestic flexibility measures like sectoral integration. This has consequences for actor diversity: The flexibility that the interconnector will provide could alternatively have been provided by a multitude of heat pumps, electric boilers, electric cars and other aggregated flexibility devices. As a form of local ownership of flexibility, such an approach would help break up the energo-material structures of the fossil energy system and increase public acceptance (Moss et al., 2015; Hvelplund and Djørup, 2019).

In the case of Viking Link, the infopower inherent to cost-benefit analysis contributes to the limiting of possible results and hence fastens a welfare-economic worldview of mainstream economics. The facts produced by the calculative device act to depoliticize decision-making, thereby fastening energopower as alternative energy system configurations are disregarded with the aid of CBA. The question remains whether Viking Link is a case of defective *use* of CBA, or whether it displays the defectiveness of CBA *per se*. While the case certainly contains elements of both, improving the CBA process (e.g. by making CBA calculations publicly available) would not remove the defectiveness, although it would make it easier to show how infopower is exerted. Because CBA makes it possible to disregard alternatives through the promotion of certain welfare-economic assumptions, the defectiveness lies with CBA *per se*.

Putting decisions regarding international interconnectors back into the political process, for example through revised regulation of transmission system operators, could open up for different tools like multi-criteria analysis which could in turn reduce the infopower that calculative devices like CBA exert on the energy transition. The Viking Link CBA thus acts as a concrete example of why new economic thinking (Göpel, 2016; Hasberg, 2020, Ch. 3; Røpke, 2020) is a necessity for achieving a sustainability transition.

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